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(54) Title: CONVERTING UNSTRUCTURED INFORMATION INTO STRUCTURED INFORMATION

(57) Abstract: The invention provides a technique for allowing unstructured information to be communicated, and for allowing the receiver of that unstructured information to convert it into structured information for relatively effective, rapid, and reliable classification. Unstructured information is received and processed by a system performing a selected protocol, and in which the selected protocol determines a set of follow-on requests for information with which to respond to the unstructured information. The follow-on requests for information, and responses thereto, allow the receiver to classify and structure the originally unstructured information, and to make a response that is appropriate to the originally unstructured information. The system performing the selected protocol includes a customer (patient) client device, such as the "Health Buddy" device described in the Incorporated Disclosures, capable of communicating with a provider server device, such as the information clearinghouse described in the Incorporated Disclosures. The client device can be augmented by: patient sensors, patient-initiated communication elements, and transportable patient miniclient devices. Patient sensors can monitor or sense medical information (such as blood gas data, blood glucose data, or weight) or patient compliance with a medical regimen (such as use of prescribed medication). Patient-initiated communication elements can send information to the provider without prompting by the provider (such as when the patient has a question, when the patient thinks there is an alert condition, or when the patient sensors detect a possible alert condition). Transportable patient miniclient devices can sense and record information for the patient (such as blood gas data or heartbeat), so as to send that information to the provider when later coupled to the patient client device, and can provide a communication channel for alert messages.

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Title of the Invention

Converting Unstructured Information into Structured Information

Related Applications

Inventions described herein can be used in combination or conjunction with inventions described in the following patent application(s):

- Application Serial No. 09/201,323, Express Mail Mailing No. EE143637591US, filed November 30, 1998, in the name of Stephen I. Brown, titled "Leveraging Interaction with A Community of Individuals," assigned to the same assignee, attorney docket Number HHN-007, and all pending cases claiming priority thereof;
- Application Serial No. 09/203,880, Express Mail Mailing No. EE143637557US, filed December 1, 1998, in the name of Stephen J. Brown, titled "Using a Computer Communication System with Feedback to Dispense Medicine," assigned to the same assignee, attorney docket number fiIN-002, and all pending case claiming priority thereof.
- Application Serial No. 09/216,012, Express Mail Mailing No. EE143637530US, filed December 1, 1998, titled "Treatment Regimen Compliance and Efficacy with Feedback", assigned to the same assignee, attorney docket number 1-11N-015, and all pending cases claiming priority thereof.

- Application Serial No. 09/274,431, Express Mail Mailing No. EJ384008772US, filed March 22, 1999, in the name of Stephen I. Brown, titled "Research Data Collection and Analysis" assigned to the same assignee, attorney docket number HHN-011, and all pending cases claiming priority thereof.
- Application Serial No. 09/273,812, Express Mail Mailing No. EJ384008786US, filed March 22, 1999, in the name of Stephen J. Brown, titled "Home Heath Care", assigned to the same assignee, attorney docket number mm-012, and all pending cases claiming priority thereof.
- Application Serial No. 09/274,433, Express Mail Mailing No. EJ384008769US, filed on March 22, 1999, in the name of Stephen J. Brown, titled Client -Initiated Leveraged Interaction with Providers', assigned to the same assignee, attorney docket number HHN-021 and all pending cases claiming priority thereof.
- Application Serial No. 09/293,363, Express Mail Mailing No. EJ651718931US, filed April 16, 1999, in the name of Stephen J. Brown, titled "A System and Method for Modifying Documents Sent Over a Communications Network" assigned to the same assignee, attorney docket number HHN-O25, and all pending cases claiming priority thereof.
- These applications are each hereby incorporated by reference as if fully set forth herein. These applications are collectively referred to herein as "Incorporated Disclosures."

Background of the Invention

1. *Field of the Invention*

This invention relates to electronic communication, such as converting unstructured information into structured information when received by a service provider from a customer.

2. *Related Art*

Computer communication allows substantial amounts of useful information to be sent and received relatively quickly and reliably. For example, individuals' can send messages to other individuals using electronic mail, and individuals can publish information for general use using the World Wide Web (the "web"). A first advantageous use of computer communication is electronic commerce, in which information is exchanged among or between parties to a commercial transaction, such as between buyers and sellers, or between customers and providers. A second advantageous use of computer communication is providing an interface between a set of customers and an individual provider, so that the service provider can receive and respond to customer requests, and can solicit and fulfill customer business.

One set of systems in which computer communication can provide an interface between customers and an individual service provider is shown in the Incorporated Disclosures, in which the customer is a patient and the provider is a health care provider, (such as a doctor or medical office). The Incorporated Disclosures show that medical personnel (provider) can solicit information from customers (patients), so as to make effective use of the provider's expertise when interacting with a large number of customers. As shown in the Incorporated Disclosures, these advantages can be obtained for a variety of possible provider/customer interactions, and can be obtained whether the communication is initiated by the provider or by the customer.

One problem in the known art is that communication between the customer and the provider is most efficient when the provider is able to classify the communication (effectively, rapidly, and reliably), so as to determine a response. For a first example, medical personnel would like to determine whether the patient is calling with a question, a request for a routine service, or a medical emergency. For a second example, service providers would like to determine whether customers are calling with purchase orders, requests for technical help, or complaints.

One known method is to limit the types of information that are communicated. For a first example, the provider can limit its communications to the customer for information to pre-selected, specific, requests for data (formatted in a pre-selected, specific, way). For a second example, the provider can limit those communications it accepts to a set of pre-selected, specific, types, of information. While these methods generally achieve the purpose of

structuring the information communicated between customer and provider, they have the drawback that any information not fitting into the pre-selected structure cannot be effectively communicated. It may occur that such information is quite important.

Accordingly, it would be advantageous to provide a technique for allowing unstructured information to be communicated, and for allowing the receiver of that unstructured information to convert it into structured information for relatively effective, rapid, and reliable classification. This advantage is provided in an embodiment of the invention in which unstructured information is received and processed by a system performing a selected protocol, and in which the selected protocol determines a set of follow-on requests for information which to respond to the unstructured information. The follow-on requests for information, and responses thereto, allow the receiver to classify and structure the originally unstructured information. This allows the receiver to make a response that is appropriate to the originally unstructured information.

Summary of the Invention

The invention provides a method and system for allowing unstructured information to be communicated, and for allowing the receiver of that unstructured information to convert it into structured information for relatively effective, rapid, and reliable classification. Unstructured information is received and processed by a system performing a selected protocol, and in which the selected protocol determines a set of follow-on requests for information with which to respond to the unstructured information. The follow-on requests for information, and responses thereto, allow the receiver to classify and structure the originally unstructured information. This allows the receiver to make a response that is appropriate to the originally unstructured information.

In a preferred embodiment, the system performing the selected protocol includes a customer (patient) client device, such as the "Health Buddy" device described in the Incorporated Disclosures, capable of communicating with a provider server device, such as the information clearinghouse described in the Incorporated Disclosures. The client device can be augmented by patient sensors, patient-initiated communication elements, and transportable patient miniclient devices. Patient sensors can monitor or sense medical information (such as blood gas data, blood glucose data, or weight) or patient compliance with a medical regimen (such as use of prescribed medication). Patient Initiated communication elements can send

information to the provider without prompting by the provider (such as when the patient has a question, when the patient thinks there is an alert condition, or when the patient sensors detect possible alert condition). Transportable patient miniclient devices can sense and record information for the patient (such as blood gas data or heartbeat), so as to send that information to the provider when later coupled to the patient client device, and can provide a communication channel for alert messages.

The invention provides an enabling technology for generalized communication between parties that have a need to classify information they receive, to obtain substantial advantages and capabilities that are novel and non-obvious in view of the known art. Examples described below relate to triage of patient communications with medical personnel, but the invention is broadly applicable to many different types of transactions.

Brief Description of the Drawings

Figure 1 shows a block diagram of a system for converting unstructured information into structured information.

Figure 2 shows a process flow diagram of a method for operating a system for converting unstructured information into structured information.

Detailed Description of the Preferred Embodiment

In the following description, a preferred embodiment of the invention is described with regard to preferred process steps and data structures. Embodiments of the invention can be implemented using general-purpose processors or special purpose processors operating under program control, or other circuits, adapted to particular process steps and data structures described herein. Implementation of the process steps and data, structures described herein would not require undue experimentation or further invention.

System Elements

Figure 1 shows a block diagram of a system for converting unstructured information into structured information.

A system 100 includes one or more client device(s) 110, one or more expert workstation(s) 120, and a server device 130. The client device 110, the expert workstation 120 and the service device 130 are coupled using a communication network 140.

Each of the one or more client(s) 111 uses a client device 110. Each client device 110 includes an output element 112, an input element 113, a port 114 and a variety of peripheral appliances 115. The client 111 manipulates the client device 110 to send both unstructured and structured information from the client 111 to the server 130 and to receive information from the protocol 131.

Port 114 can be coupled to a variety of peripheral appliances 115, including medical sensors, medicinal applicators, or patient-initiated communication elements. The medical sensors and medicinal applicators can provide data for the client device 110, and can accept instructions from the client device 110. The client device 110 performs a protocol, by which it can send that data to server 130, evaluate that data, and provide instructions to the peripheral appliances 115.

The patient-initiated communication elements can include transportable mini-clients, such as an "alert" button, a pager, a Palm Pilot or other hand-held computer, or another type of device, preferably including an input element (for receiving information and answers to protocol questions from the patient 111) and an output element (for presenting questions, data, and suggested actions to the patient 111). Integration of such transportable mini-clients into the system, such as to allow patient-initiated communication, is further described in the Incorporated Disclosures.

The patient-initiated communication elements and other peripheral appliances 115 can thus generate data, or receive patient input, and thus provide a patient-initiated communication to the server 130. Presentation of patient-initiated communications to the server 130 and to the expert workstation 120, in conjunction with performance of a protocol at the client device 110, is further described in the Incorporated Disclosures.

Receipt of the unstructured information at the server 130 alerts the server 130 to parse the unstructured information (if possible), and to select at least one client protocol to send to the

client device 110 for responding to that unstructured information. The server 130 performs a process having the following features:

- When the unstructured data includes text, the process is responsive to selected words found in that text. For example, the process is responsive to words with medical implications such as (in a cardiac context) "chest pain" or "heart", or (in a diabetes context) "sores" or "toes". In a preferred embodiment, the process is adjusted to be more or less responsive to elected words in response to (a) new medical data about medical conditions, (b) new jargon entering or leaving common language usage, (c) statistical or other medical information about the population of patients III being served by the server 120. For example, if the population of patients 111 includes a large number of former coal-mine workers, the process can be adjusted to be more sensitive to text regarding matters relating to breathing or coughing.

Although not described in detail here, the concept of searching text for keywords, and various methods for assigning scores to text in response to keywords, are known in the art of using text as data. Unlike the known art, an aspect of the invention is to select a protocol for performance at the client device 110, so as to convert the otherwise unstructured information presented by text (even if it can be searched in response to keywords) to structured information by a sequence of follow-up questions and answers.

- The process is responsive to demographic or medical history information about particular patient 111 making the patient-initiated contact. For example, if the particular patient 111 has a history of heart disease or is known to be in a high-risk category for heart disease, the process gives more weight to words relating to cardiac problems, and is more likely to select a client protocol relating thereto. Similarly, if the patient-initiated contact is an undifferentiated help call, the process selects a client protocol related to the patient's medical history or most likely immediate need.
- The process is responsive to history information about patient-initiated contact relating to the particular patient 111. For example, if the particular patient 111 has a history of making very many help calls which are later shown to be unnecessary, the process is more likely to select a client protocol at a relatively lower level of alert. Similarly, if the particular patient 111 has a history of not making patient-initiated contacts even when

other peripheral devices 115 indicate a real need, the process is more likely to select a client protocol at a relatively lower level of alert when the particular patient 111 finally calls for help.

- The process is responsive to medical and other data from the other peripheral devices 115 coupled to the client device 110. In a preferred embodiment, the process can select and send a triage protocol (as further described in the Incorporated Disclosures), which can read data from the other peripheral devices 115 and determine a level of immediacy required by the particular patient 111.

The selected protocol is sent to the client device 110 and performed by the client device 110 in response to the unstructured information. The selected protocol, in response to the unstructured information, presents structured questions and answers to the patient 111, thus obtaining structured information from the patient 111 that can be processed in a standardized way. Moreover, the selected protocol can receive data from the peripheral devices 115 in a structured format, thus obtaining structured information from the peripheral devices 115 that can be processed in a standardized way.

The selected protocol can, in response to the structured information, send messages (with a selected degree of urgency) to the expert workstation 120 regarding the patient 111. For example, the selected protocol can determine the urgency of the ailment or other matter, and automatically schedule an office visit, call a triage nurse, page a doctor, or call an ambulance, if the structured information indicates that the situation warrants.

The selected protocol can, in response to the structured information, also present information to the patient 111. For example, the selected protocol can reassure the patient 111 if the matter is in fact much less serious than the patient 111 indicates. The selected protocol can inform the patient 111 of the nature of the ailment or other matter, much as an in-person expert would explain at an office visit. The selected protocol can also, in response to the structured information, direct the patient 111 to take ameliorating steps regarding the ailment or other matter, such as to breathe deeply, lie down, or stop excessive activities.

The selected protocol can, in response to the structured information, also control one or more peripheral devices 115 so as to ameliorate the ailment or other matter. For example, the

selected protocol can cause a medicinal applicator to operate, such as to open to allow the patient to consume prescription medication, or such as to automatically operate to provide the patient oxygen.

Each of the one or more expert(s) 121 uses an expert workstation 120. Each expert workstation 120 includes an output element 122 and an input element 123.

The server device 130 includes a protocol 131, a database 132 and protocol logic 133.

For further information regarding a data structure and simplified research subject interface, and preferred embodiments of the client 110, medical expert device 120 and the server device 130 including data base 132, see related Application Serial No. 09/201,323 Express Mailing No. EE143637591US, filed November 30, 1998 in the name of Stephen J. Brown, titled "Leveraging Interaction with a Community of Individuals," assigned to the same assignee, attorney docket number HHN-007, and other related applications incorporated by reference therein.

For further information regarding the protocol or other intelligent message used by the system, see related Application Serial No., _____, Express Mailing No. E143637565US, filed December 1, 1998, in the name of Stephen J. Brown, titled "Remote User Data Collection Protocols Including Data Structures and User Interface;" assigned to the same assignee, attorney docket number HHN-002 and other related applications incorporated by references therein.

For information regarding a medicine dispenser which can be used by the system, see related Application Serial No. 09/203/880, Express Mail Mailing No. EE143637557US, filed December 1, 1998, in the name of Stephen J. Brown, et al., titled "Using a Computer Communication System with Feedback to Dispense Medicine", assigned to the same assignee, attorney docket number HHN-005, and other related applications incorporated by reference therein.

For information regarding genotype and phenotype correlation, see related Application Serial number 08/850,840, Express Mail Mailing No. E1113824573US, filed May 3, 1998 in the name of Stephen J. Brown, et al. titled "System and Method for Preventing, Diagnosing and

Treating Genetic and Pathogen-Caused Disease", assigned to the same assignee, attorney docket number RYA-128 and Application Serial No 09/041,809, Express Mail Mailing No. EE262620680US, filed March 13, 1998 in the name of Stephen J Brown, et al. titled Phenoscope and Phenobase", assigned to the same assignee, attorney docket number RY A 136, and any other related applications incorporated by reference therein.

Method of Operation

Figure 2 shows a process flow diagram of a method for operating a system for converting unstructured information into structured information.

A method 200 is performed by a system 100, as follows:

At a flow point 201, the system 100 is ready to proceed.

At a step 202, a medical expert 121 enters, at an expert workstation 120, information relating to a selected patient 111 and a set of protocols to possibly be performed at the client device 110 for that selected patient 111. In a preferred embodiment, the set of protocols is selected from a larger set of protocols pre-provided by a maker of the system 100 or of the expert workstation 120.

Information relating to a selected patient 111 can include the patient's medical history, the patient's stated reason(s) for using the client device 110, the patient's current medical status, and a list of medical professionals involved with care of the client (for example a doctor, a nurse, a pharmacist, a home health aide or local ambulance service). This information includes a list of key words that are relevant to the patient's medical condition(s) and history, and a set of key words. The set of protocols can include both scripts unique to the patient 111, scripts related to the patient population, and one or more generic or specific triage protocols.

At a step 203, the research information and set of protocols are sent to a server device 130 using the communication network 140.

At a step 204, the server device 130 records the information and set of protocols in the database 132.

At a step 205, the server device 130 sends the information to other health professionals involved with the care of the client 111. At this flow point, the server device 130 is ready to communicate with the client device 110, convert unstructured communications into structured one and classify communications.

At a step 206, the server 130 receives unstructured information concerning a patient 111. The unstructured information can be sent from the client device 110, from a peripheral 115 associated with the client device 110, or from another expert workstation 120.

At a step 207, the server 130 parses the unstructured information, and in response thereto, selects at least one protocol for converting the unstructured information into structured information.

At a step 208, the server device 130 sends the selected protocol to the client device 110 where the unstructured information originated.

At a step 209, the client device 110 performs the selected protocol, which presents questions and solicits follow-up information from the patient 111. Performing the selected protocol provides a set of structured information from the patient 111.

At a step 210, the patient 111 interacts with the selected protocol by manipulating the client device 110.

At a step 211, the selected protocol sends the structured information to the server 130.

At a step 212, the server device 130 stores the structured information and the associated unstructured information in the database 132.

At a step 213, expert 121 at the expert workstation 120 can review the structured information for a population of patients 11. This review can include aggregate review of the population or specific review of a selected patient 111. This review can also include detailed human review of the unstructured information (but likely will not).

At a step 214, the medical expert 121 can send messages to the client 111 or client device 110 to ameliorate the circumstance that caused the client 111 to initiate the interaction. These messages could include emergency directions, medical advice, or other instructions.

At a step 215, the system 100 has performed the method 200 and is ready for further unstructured information.

Generality of the Invention

The invention has general applicability to various fields of use, not necessarily related to the services described above. For example, these fields of use can include one or more of, or some combination of, the following (or any related fields):

- Medical or psychological treatment of patients. This can include monitoring of patients, therapy actively performed by those patients, patient compliance and home health services.
- Registration, benefits or other related services for individuals. This can include gathering information for governmental or insurance services tailored to selected individuals.
- Education and training of individuals. This can include education programs for those individuals and assessment of students who use microprocessor based virtual reality simulators and related tools.
- Market research. This can include tracking and analyzing customer complaints, general data mining, data analysis, opinion polls or surveys.
- Workplace issues. This can include resume classification, tracking and analyzing workload and workers' compensation.

Other and further applications of the invention in its most general form would be clear to those skilled in the art after perusal of this application and are within the scope and spirit of the invention.

Technical Appendix

A technical appendix enclosed herewith provides further information regarding embodiments of the invention. This technical appendix is part of the disclosure and is hereby incorporated by reference as if fully set forth herein.

Alternative Embodiments

Although preferred embodiments are disclosed herein, many variations are possible which remain within the concept, scope, and spirit of the invention, and these variations would become clear to those skilled in the art after perusal of this application.

Claims

1. A method, including steps of
Selecting a protocol to be performed in response to a set of unstructured information,
said protocol including a sequence of structured triggers and responses;

performing said protocol, whereby said structured triggers and responses include
structured information in response to said unstructured information.
2. A method as in claim 1, including steps of classifying said structured information
into at least one of a set of selected categories.
3. A method as in claim 1, including steps of
recording said structured information at an information clearinghouse; and
recording said unstructured information at said information clearinghouse in association
with said structured information.
4. A method as in claim 1, including steps of selecting at least one action in
response to said structured information, wherein said action includes at least one of: sending an
alert message, providing information to a sender of said unstructured information, or operating a
device logically local to said sender.
5. A method as in claim 1, wherein said steps of performing said protocol include
steps for
presenting a sequence of triggers and eliciting a corresponding sequence of responses at
a first device, and
sending information regarding said corresponding sequence of responses from said first
device to a second device.
6. A method as in claim 1, wherein said steps of selecting a protocol include steps
of
sending said unstructured information from a first device to a second device;
selecting said protocol at said second device; and
sending said selection from said second device to said first device.
7. A method as in claim 1, wherein said unstructured information includes at least
one of: an alert, information originated

8. A method of doing business including providing services to a set of customers, said services including application of expertise to information regarding selected ones of said customers, said method including steps of

receiving messages from selected ones of said customers, said messages including a set of unstructured information;

converting said unstructured information into a set of corresponding structured information; and

applying expertise to at least some of said structured information.

9. A method as in claim 8, including steps of
classifying said structured information into at least one of a set of selected categories;
and

performing said steps of applying expertise in response to said steps of classifying.

10. A method as in claim 8, wherein said services include at least one of: benefits services, classification of applications or resumes, classification of essays or speeches, classification of written material, educational or training services, emergency services, legal services, medical services, opinion poll services, physical therapy services, police or fire services, psychological services, registration services, services for collecting information, services for providing information, services for responding to complaints, or workers compensation services.

11. A method as in claim 8, wherein said steps of converting include steps of
presenting a sequence of triggers and eliciting a corresponding sequence of responses at a first device; and

sending information regarding said corresponding sequence of responses from said first device to a second device.

12. A method as in claim 8, wherein said unstructured information includes at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.

13. An article of manufacture, said article including a computer data signal embodied in readable medium, said readable medium including at least one of the following: a carrier wave, a memory, or a storage device; said data signal including a protocol to be performed in response to a set of unstructured information, said protocol including a sequence of structured triggers and responses.

14. An article as in claim 13, wherein said unstructured information includes at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.

15. Apparatus including

an input device including a plurality of differentiated selections for input information, whereby said input information can include unstructured information;

a computing element capable of selecting a protocol in response to said unstructured information, said protocol including a sequence of structured triggers and responses;

an output device including a plurality of differentiated presentations for said triggers,

whereby a set of corresponding responses, entered at said input device, in response to said triggers presented at said output device, include structured information in response to said unstructured information.

16. Apparatus as in claim 15, including a memory recording said structured information, said memory also recording said unstructured information in association with said structured information.

17. Apparatus as in claim 15, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.

18. Apparatus including

a first device having an input element, an output element, and a first computing element, said input element including a plurality of differentiated selections for input information, whereby said input information can include unstructured information;

a second device having a second computing element capable of selecting a protocol in response to said unstructured information, said protocol including a sequence of structured triggers and responses;

a communication link between said first device and said second device; and

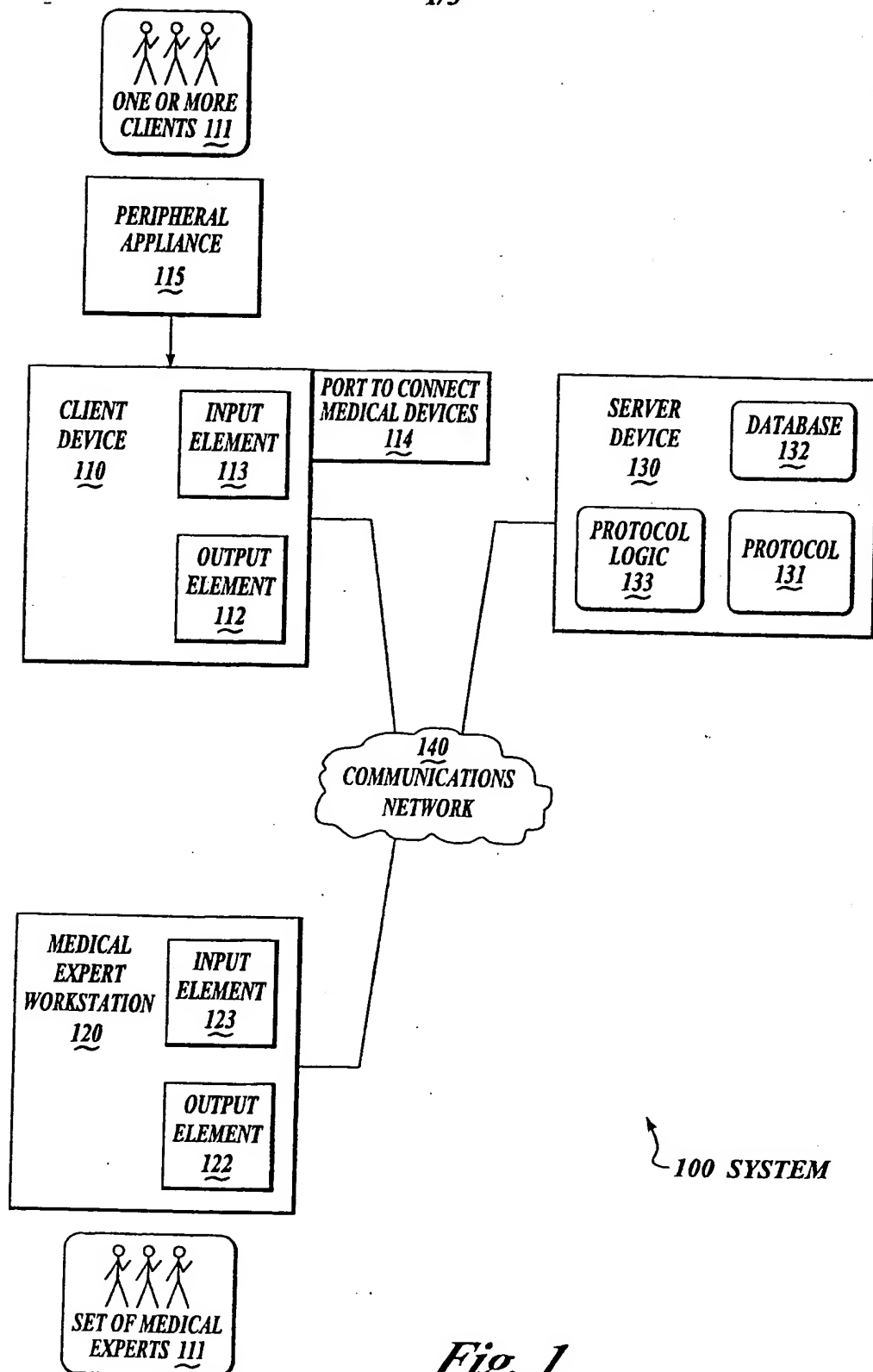
a set of structured information responsive to said unstructured information and to performance of said protocol by said an input element, said output element, and said first computing element.

19. Apparatus as in claim 18, including an information clearinghouse coupled to said communication link, said information clearinghouse having structured information recorded in association with said unstructured information.

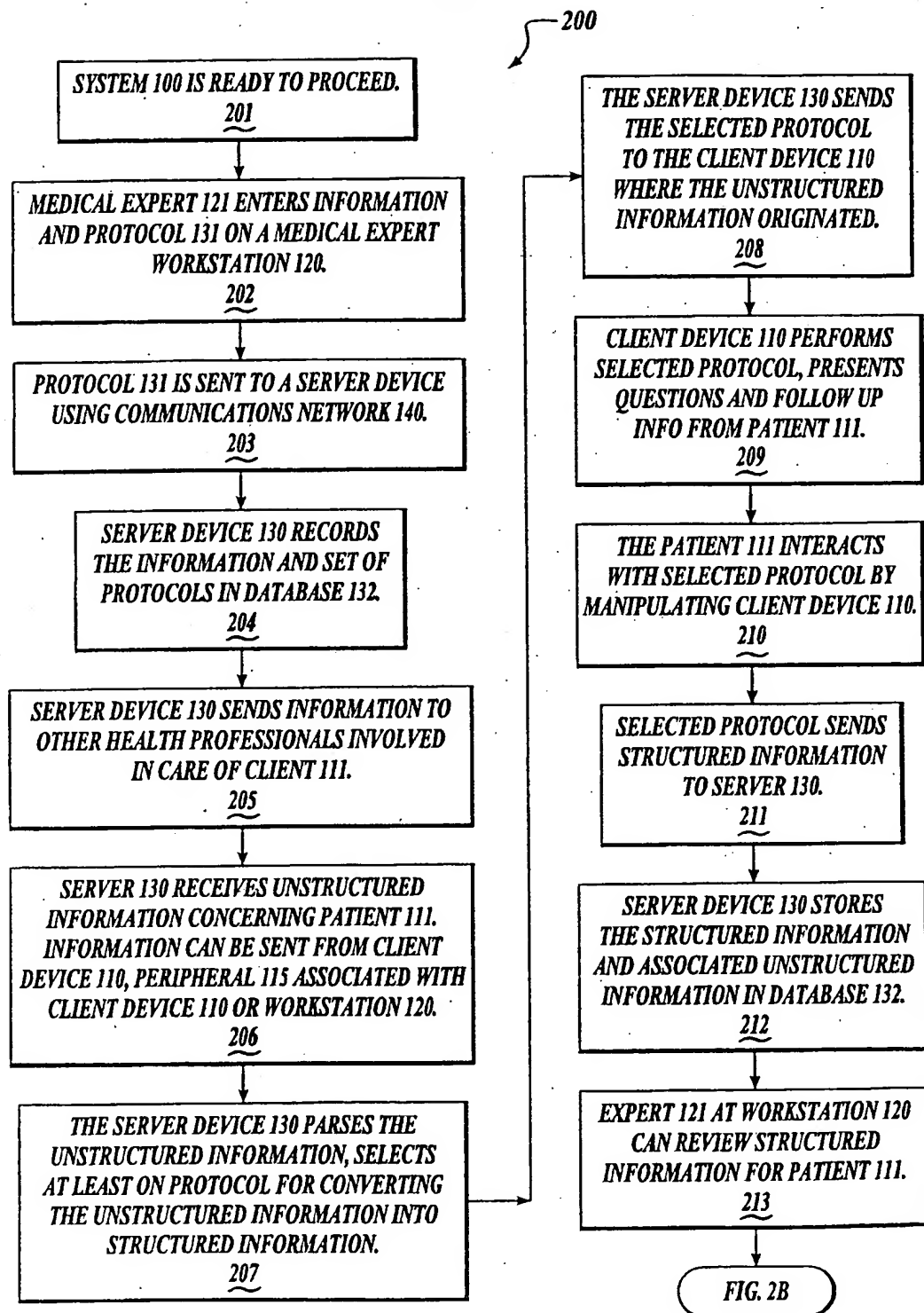
20. Apparatus as in claim 18, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.
21. In a method of doing business including providing services to a set of customers, said services including application of expertise to information regarding selected ones of said customers, a computer protocol for converting a set of unstructured information into a set of corresponding structured information.
22. A computer protocol as in claim 21, said protocol including a sequence of structured triggers and responses.
23. A computer protocol as in claim 21, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.
24. In a method of doing business including providing services to a set of customers, said services including application of expertise to information regarding selected ones of said customers, a data structure including a set of structured information in association with a set of corresponding unstructured information, said structured information being responsive to said corresponding unstructured information.
25. A data structure as in claim 24, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.
26. In apparatus for providing services to a set of customers, said services including application of expertise to information regarding selected ones of said customers, a computer protocol for converting a set of unstructured information into a set of corresponding structured information.
27. A computer protocol as in claim 26, said protocol including a sequence of structured triggers and responses.
28. A computer protocol as in claim 26, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.
29. In apparatus for providing services to a set of customers, said services including application of expertise to information regarding selected ones of said customers, a data structure including a set of structured information in association with a set of corresponding unstructured information, said structured information being responsive to said corresponding unstructured information.

30. A data structure as in claim 29, including within said unstructured information at least one of: an alert, information originated by a medical patient, medical information regarding a source of said unstructured information, or natural language text.

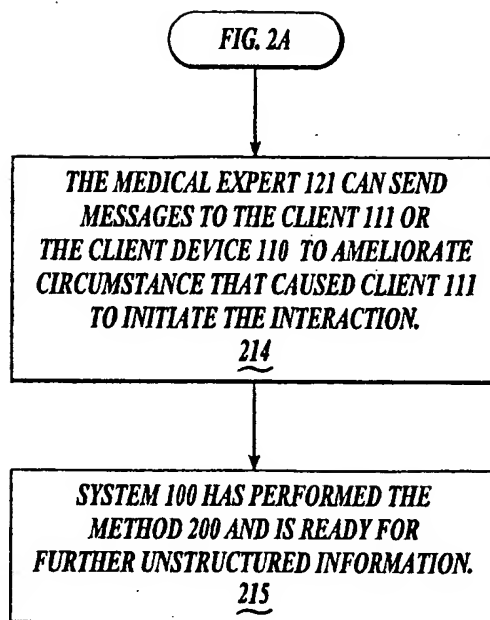
1/3

*Fig. 1*

2/3

*Fig. 2A*

3/3

*Fig. 2B*